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(12) **United States Patent**
Mak et al.(10) Patent No.: **US 6,849,545 B2**
(45) Date of Patent: **Feb. 1, 2005**(54) **SYSTEM AND METHOD TO FORM A
COMPOSITE FILM STACK UTILIZING
SEQUENTIAL DEPOSITION TECHNIQUES**(75) Inventors: **Alfred W. Mak**, Union City, CA (US);
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CA (US)(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.(21) Appl. No.: **09/885,609**(22) Filed: **Jun. 20, 2001**(65) **Prior Publication Data**

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(51) Int. Cl.⁷ **H01L 21/44**(52) U.S. Cl. **438/679; 438/769; 438/775;
438/770; 438/685; 438/683; 438/682; 257/751;
427/255.2**(58) Field of Search **438/679, 627,
438/644, 654, 682, 683, 685, 769, 770,
775**(56) **References Cited****U.S. PATENT DOCUMENTS**

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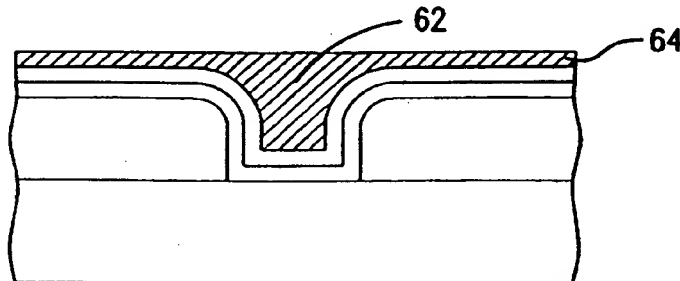
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(57)

ABSTRACT

A system and method to form a stacked barrier layer for copper contacts formed on a substrate. The substrate is serially exposed to first and second reactive gases to form an adhesion layer. Then, the adhesion layer is serially exposed to third and fourth reactive gases to form a barrier layer adjacent to the adhesion layer. This is followed by deposition of a copper layer adjacent to the barrier layer.

49 Claims, 6 Drawing Sheets



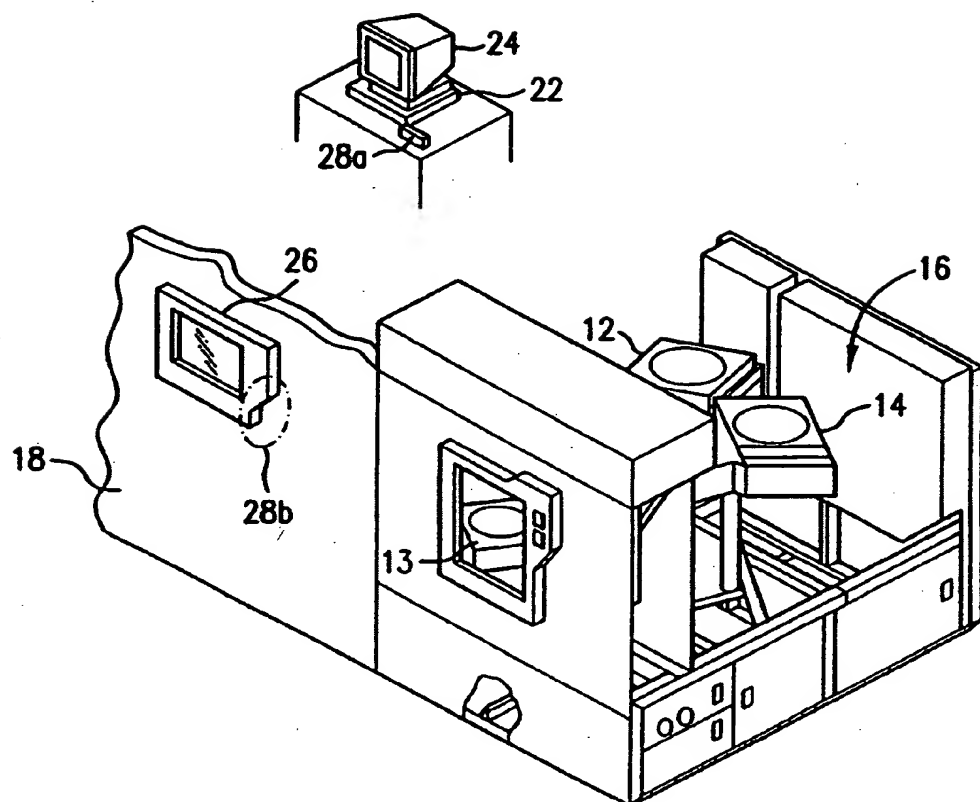


FIG. 1

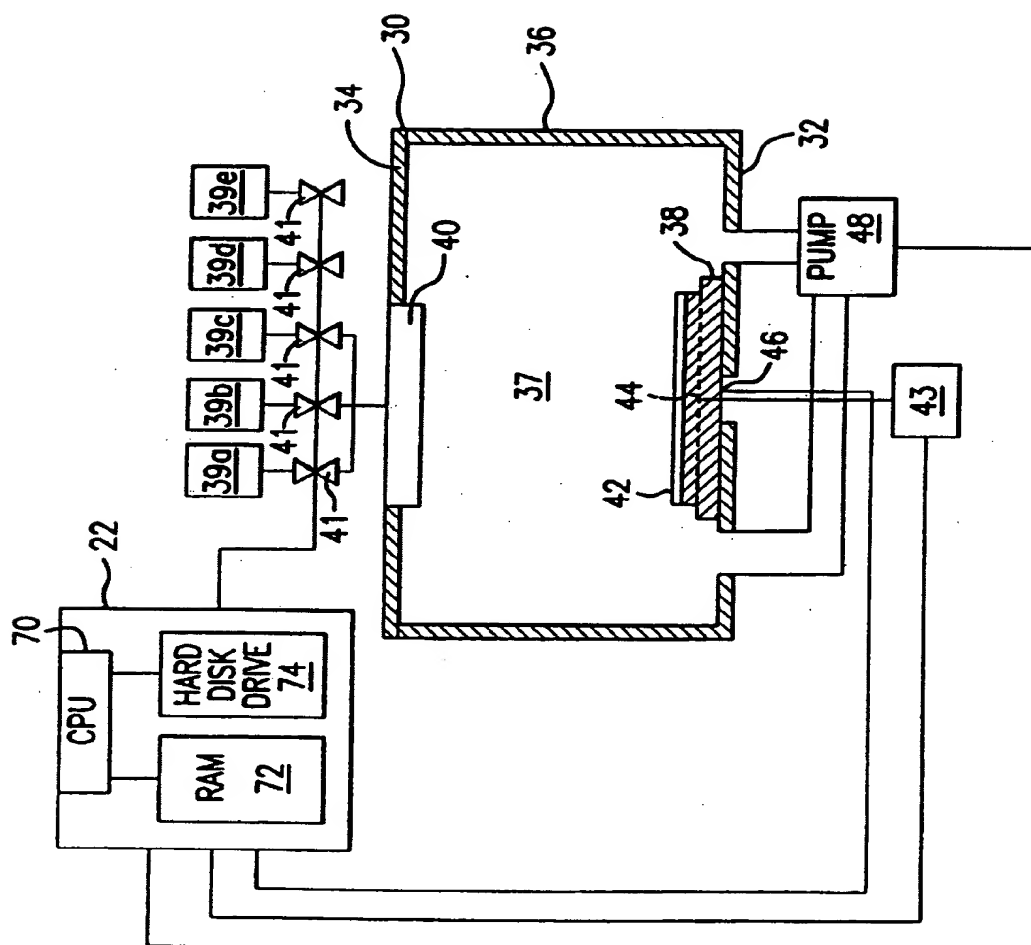


FIG. 2

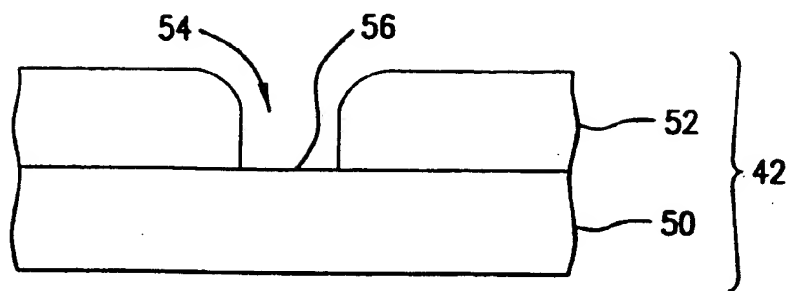


FIG. 3

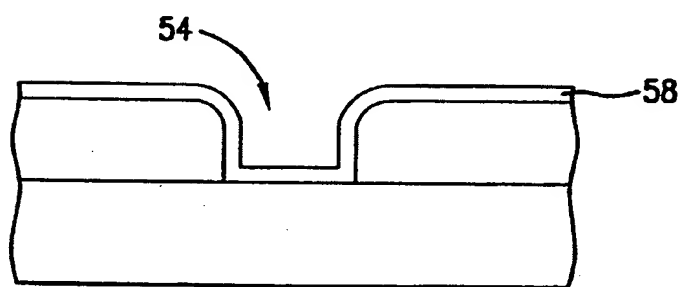


FIG. 4

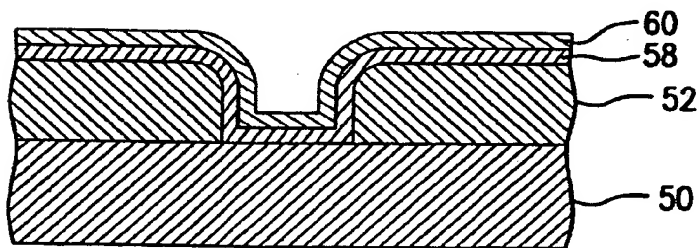


FIG. 5

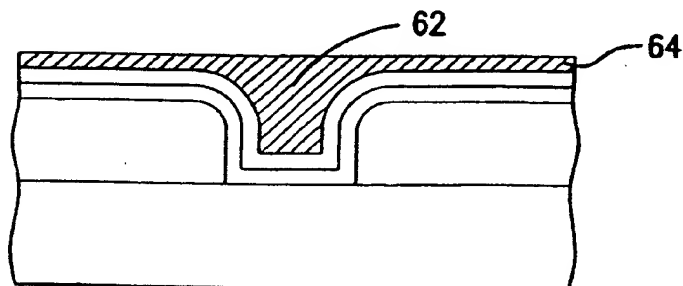


FIG. 6

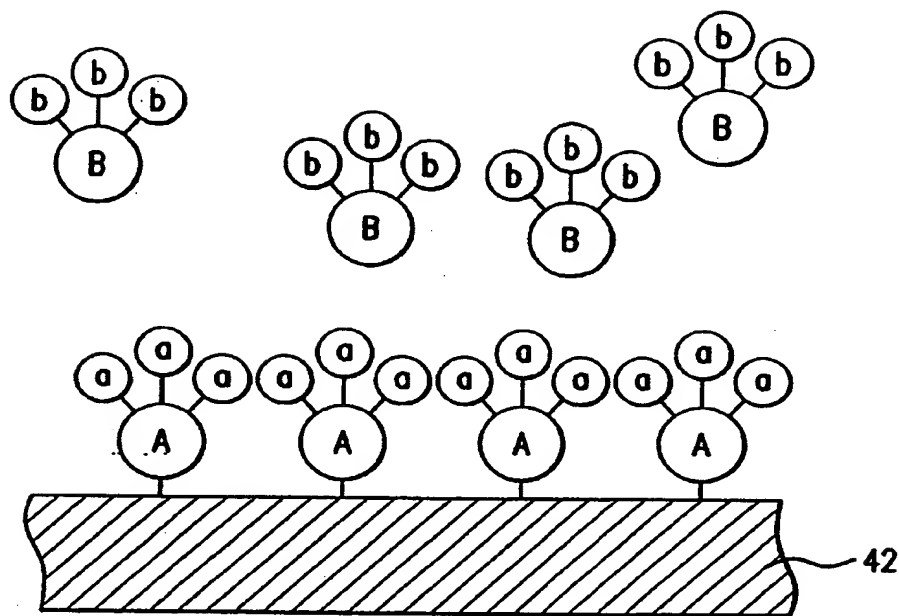


FIG. 7

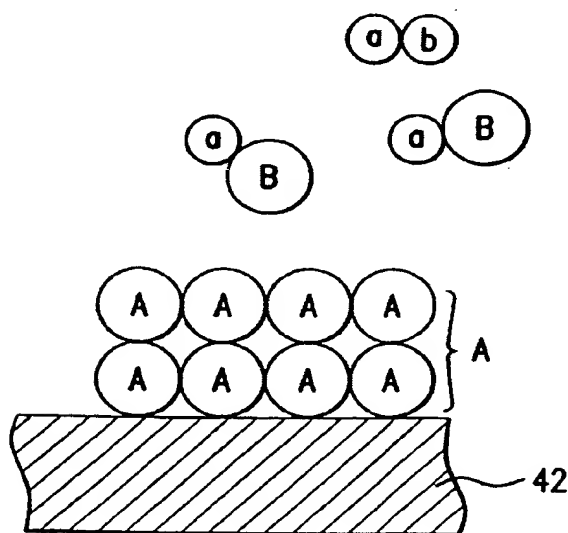


FIG. 8

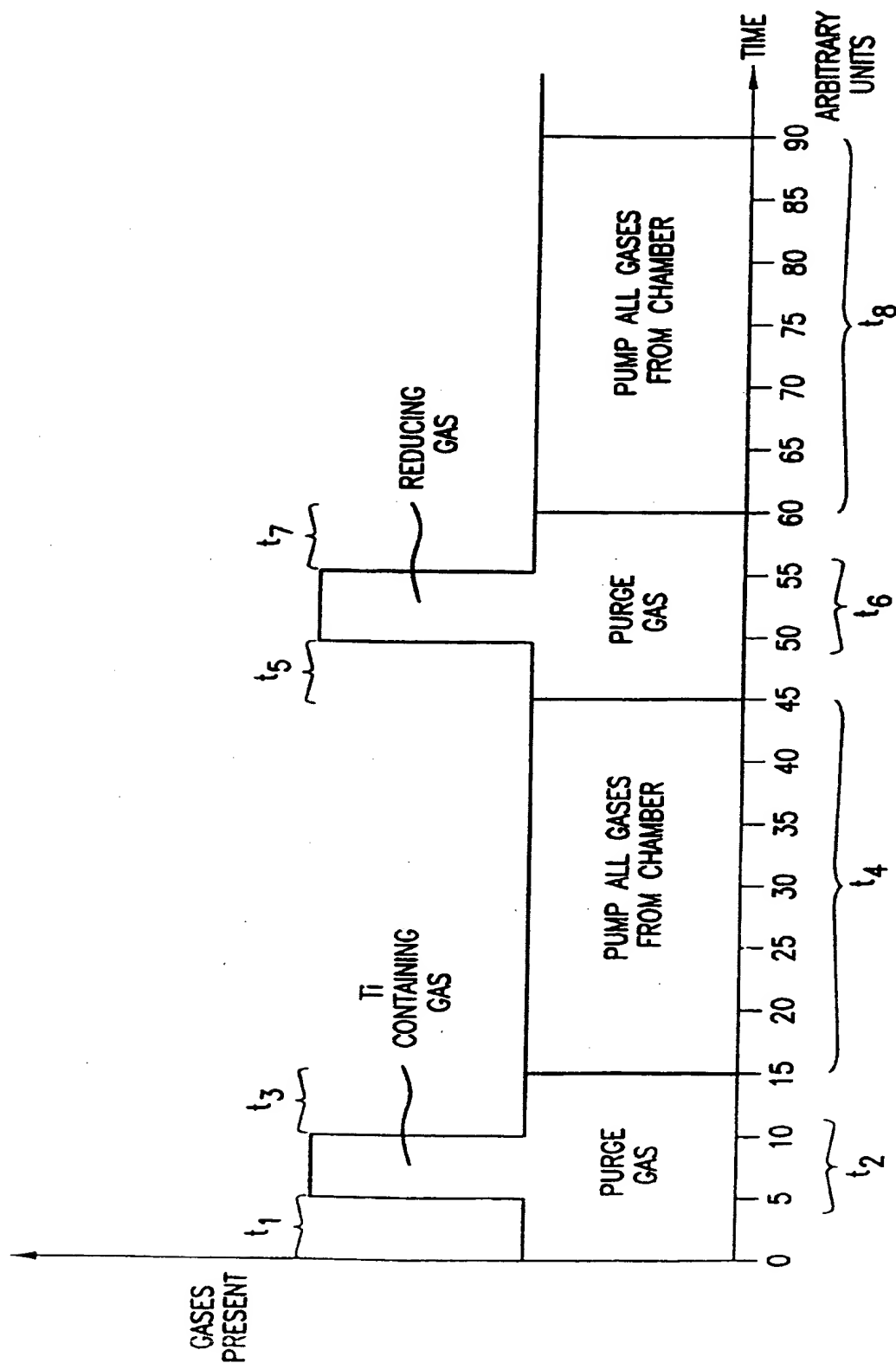


FIG. 9

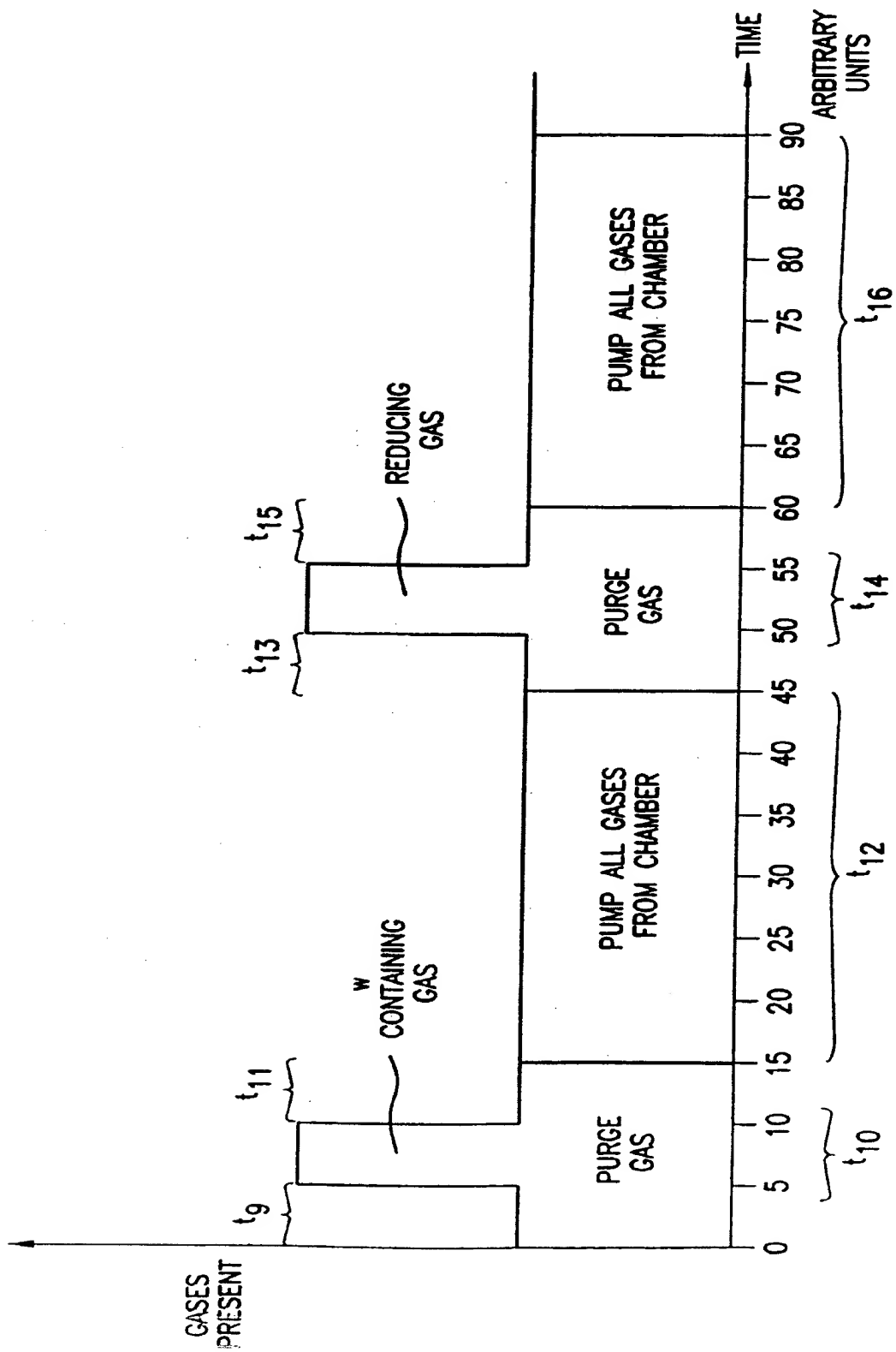


FIG. 10